

[Med. Entomol. Zool. Vol. 58 No. 4 p. 291–301 2007]

## Two new species of *Simulium* (*Simulium*) from Sabah, Malaysia (Diptera: Simuliidae)

Hiroyuki TAKAOKA

Department of Infectious Disease Control, Faculty of Medicine, Oita University,  
Hasama, Yufu City, Oita, 879-5593 Japan

(Received: 23 July 2007; Accepted: 8 August 2007)

**Abstract:** Two new species, *Simulium* (*Simulium*) *maklarini* sp. nov. and *S.* (*S.*) *liewi* sp. nov., are described on the basis of female adults reared from pupae collected from Sabah, Malaysia. Both new species are assigned to the *melanopus* species-group because of a ventrally produced paraproct with an anteroventral plate. Morphological characteristics of the female and pupa of these new species are compared with several related known species.

Key words: black fly, Simuliidae, Sabah, Malaysia, new species

The fauna of black flies (Diptera: Simuliidae) in Sabah, Malaysia was composed of 11 species in three subgenera of the genus *Simulium* Latreille s. l. (two species in *Nevermannia*, two species in *Gomphostilbia* and seven species in *Simulium* s. str.) (Edwards, 1933; Smart and Clifford, 1969; Takaoka, 1996). Takaoka (2001) added five more species consisting of one new and three newly recorded species of *Simulium* (*Gomphostilbia*) and one new species of *Simulium* (*Nevermannia*) after carrying out a survey of black flies in and around Mt. Kinabalu, Sabah in 1998.

This paper describes two new species of the subgenus *Simulium* s. str. based on female specimens reared from pupae collected during the above-mentioned survey. These two new species are easily assigned to the *melanopus* species-group defined and redefined by Takaoka (1983, 2003) in that the female paraproct is much produced ventrally and has an anteroventral plate.

The terms for morphological features used here follow those of Takaoka (2003). Holotype specimens of the new species are deposited at the Department of Infectious

Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

### *Simulium* (*Simulium*) *maklarini* sp. nov.

**DESCRIPTION. Female.** Body length 2.5 mm. **Head.** Narrower than width of thorax. Frons brownish-black, shiny, with several dark stout hairs along lateral margins and near lower margin; frontal ratio 1.22 : 1.00 : 1.19; frons-head ratio 1.00 : 3.99. Fronto-ocular area (Fig. 1A) shallow, triangular laterally. Clypeus brownish-black, shiny, silvery iridescent when illuminated at certain angle of light, moderately covered with dark stout hairs except small area near upper margin bare. Labrum 0.56 times as long as clypeus. Antenna composed of scape, pedicel, and 9 flagellomeres, medium brown except scape, pedicel, and 1st to 3rd flagellomeres yellow to dark yellow when viewed anteriorly, but scape, pedicel, and basal 1/2 of 1st flagellomere yellow and rest of flagellar segments medium brown when viewed posteriorly. Maxillary palp medium brown, composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.13 : 2.71; 3rd segment (Fig. 1B) slightly enlarged; sensory vesicle (Fig. 1B) small, ellipsoidal, 0.28 times as long as 3rd segment, with

medium-sized round opening medially. Maxillary lacinia with 11–14 inner and 15 outer teeth. Mandible with 28 inner and 13 or 14 outer teeth. Cibarium (Fig. 1C) with 62 minute tubercles. **Thorax.** Scutum brownish-black except anterior calli light brown, and pair of faint triangular submedian spots near anterior margin medium brown, markedly shiny (somewhat bluish iridescent), moderately covered with light to medium brown recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Scutellum brownish-black, shiny, with dark brown long upright hairs. Postnotum dark brown, shiny, whitish-gray pruinose when illuminated at certain angle of light and bare. Pleural membrane bare. Katepisternum longer than deep, dark brown, bare, shiny. **Legs.** Foreleg: coxa whitish-yellow; trochanter light to medium brown; femur dark brown; tibia (Fig. 1D) medium brown except outer surface whitish, and with silvery iridescence when illuminated at certain angle of light; tarsus (Fig. 1D) dark brown, with thick dorsal crest of short hairs; basitarsus greatly dilated, 4.0 times as long as its greatest width. Midleg: coxa dark brown except posterolateral surface brownish-black; trochanter and femur dark brown; tibia (Fig. 1E) dark brown except base narrowly whitish-yellow, with silvery iridescence on posterior surface when illuminated at certain angle of light; basitarsus (Fig. 1E) mostly whitish-yellow except apical tip light to medium brown; rest of tarsus (Fig. 1E) light to medium brown except base of 2nd segment whitish-yellow. Hind leg: coxa dark brown; trochanter light to medium brown; femur dark brown though base somewhat paler; tibia (Fig. 1F) dark brown except base yellowish-white, with silvery iridescence on posterior surface when illuminated at certain angle of light; tarsus (Fig. 1F) medium to dark brown except basal 3/5 of basitarsus (though base light brown) white or yellowish-white, and basal 1/2 of 2nd segment whitish-yellow; basitarsus nearly parallel-sided, 5.76 times as long as its greatest width, 0.71 and 0.60 times as wide as greatest widths of hind tibia and femur, respectively; calcipala nearly as long as width at base; pedisulcus distinct. All claws (Fig. 1G) with small subbasal tooth much longer than its basal width. **Wing.** Length 2.0 mm. Costa with spinules and hairs. Subcosta haired except apical 1/3 bare. Basal section of vein R with 1 hair medially; R<sub>1</sub> with

spinules and hairs; R<sub>2</sub> with hairs only. Hairs at base of stem vein dark brown. Basal cell absent. **Halter.** White with base light brown. **Abdomen.** Basal scale medium brown, with fringe of long hairs. Dorsal surface of abdominal segments dark brown to brownish-black except tergite of segment 2 mostly medium brown, and with dark hairs; tergite of 2nd segment with pair of large silvery iridescent dorsolateral spots broadly connected to each other medially; tergites 6–8 shiny. Ventral surface of abdominal segment 7 with large sternal plate medially. **Genitalia.** Sternite 8 (Fig. 1H) well sclerotized, moderately depressed medially, covered with 15 or 16 short to long hairs on each side, with posterior margin well demarcated from ovipositor valves; ovipositor valve (Fig. 1H) membranous, tapered posteriorly with transparent bare pointed apex, acutely bent ventrally, and covered with about 40 short to long hairs on outer surface; inner margins well sclerotized, widely concave medially, moderately separated from each other. Genital fork (Fig. 1I) of inverted-Y form; stem slender and well sclerotized, with apex moderately dilated; arms slender, each with strongly-sclerotized angulate lateral ridge. Paraproct in lateral view (Fig. 1J) much produced ventroposteriorly, about 2.8 times as wide as its basal length, covered with several medium-long stout hairs and numerous short fine hairs on lateral surface; paraproct anteroventrally with thin elongate slightly-sclerotized plate having round apical tip and about 10 short setae scattered on its surface. Cercus in lateral view (Fig. 1J) very short, with posterior margin slightly convex, about 3.9 times as wide as its greatest length, and covered with numerous hairs. Spermatheca (Fig. 1K) nearly ovoidal, 1.15 times as long as its greatest width, well sclerotized except duct and wide area of juncture to duct unsclerotized, without reticulate surface patterns; minute internal setae present; both accessory ducts subequal in diameter to each other, and also to that of main duct.

**Pupa.** Body length (excluding gill filaments) about 2.5 mm. **Head.** Integument yellowish-brown, bare except narrow areas near each posterodorsal margin covered with minute round tubercles (Fig. 2A); frons with 2 simple (or bifid) short trichomes moderately separated from each other (Fig. 2B) on each side; face with 1 simple medium-long trichome (Fig. 2C)

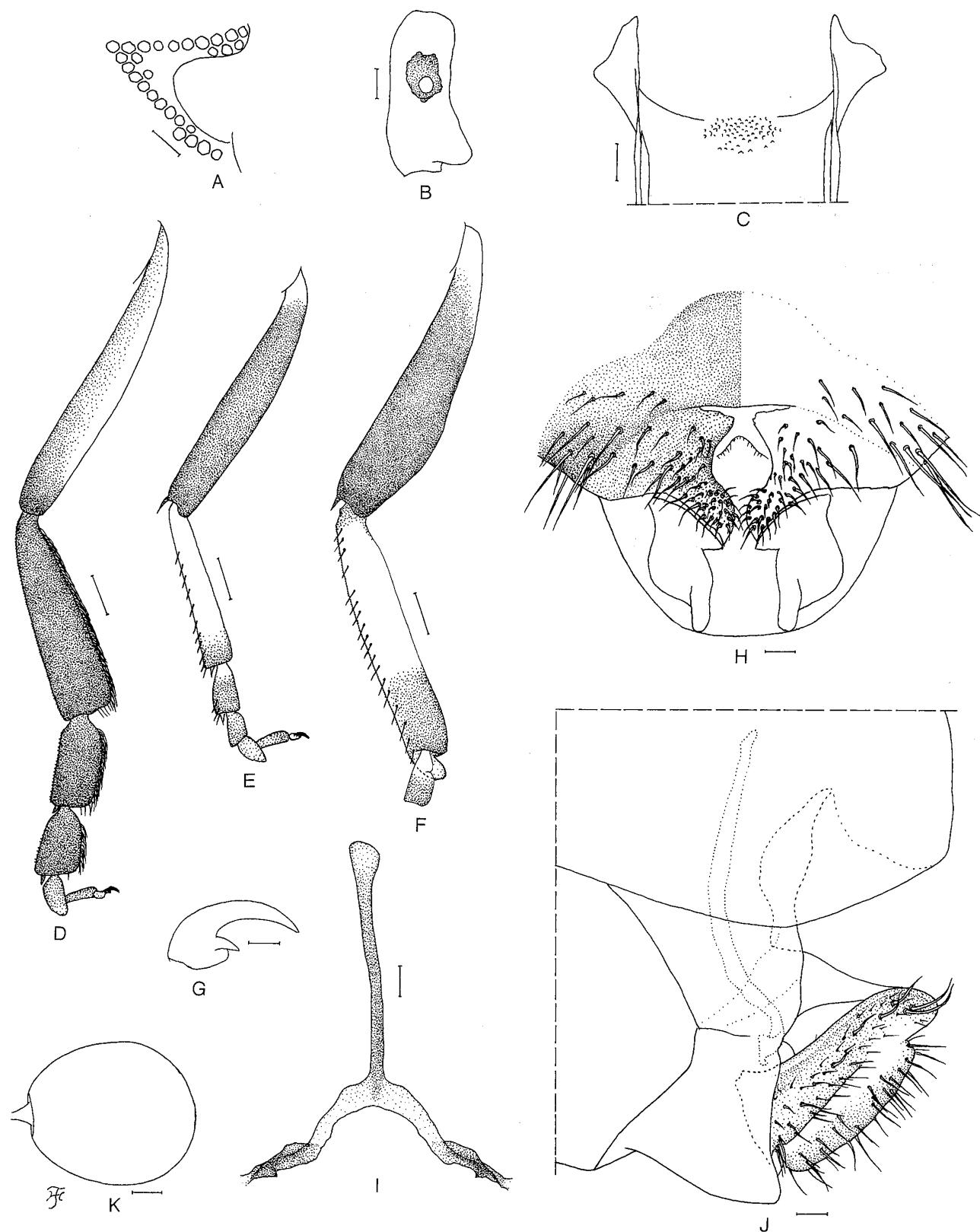


Fig. 1. Female of *Simulium (Simulium) maklarini* sp. nov. A, fronto-ocular area (right side); B, 3rd segment of maxillary palp with sensory vesicle (right side, front view); C, cibarium; D, tibia and tarsus of foreleg (right side, outer view); E, tibia and tarsus of midleg (left side, outer view); F, tibia, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side, outer view); G, claw; H, 8th sternite and ovipositor valves *in situ* (ventral view); I, genital fork (ventral view); J, posterior tip of abdomen showing 8th sternite, ovipositor valve, genital fork, paraproct and cercus *in situ* (lateral view); K, spermatheca. Scale bars. 0.1 mm for D-F; 0.04 mm for A; 0.02 mm for B, C and H-K; 0.01 mm for G.

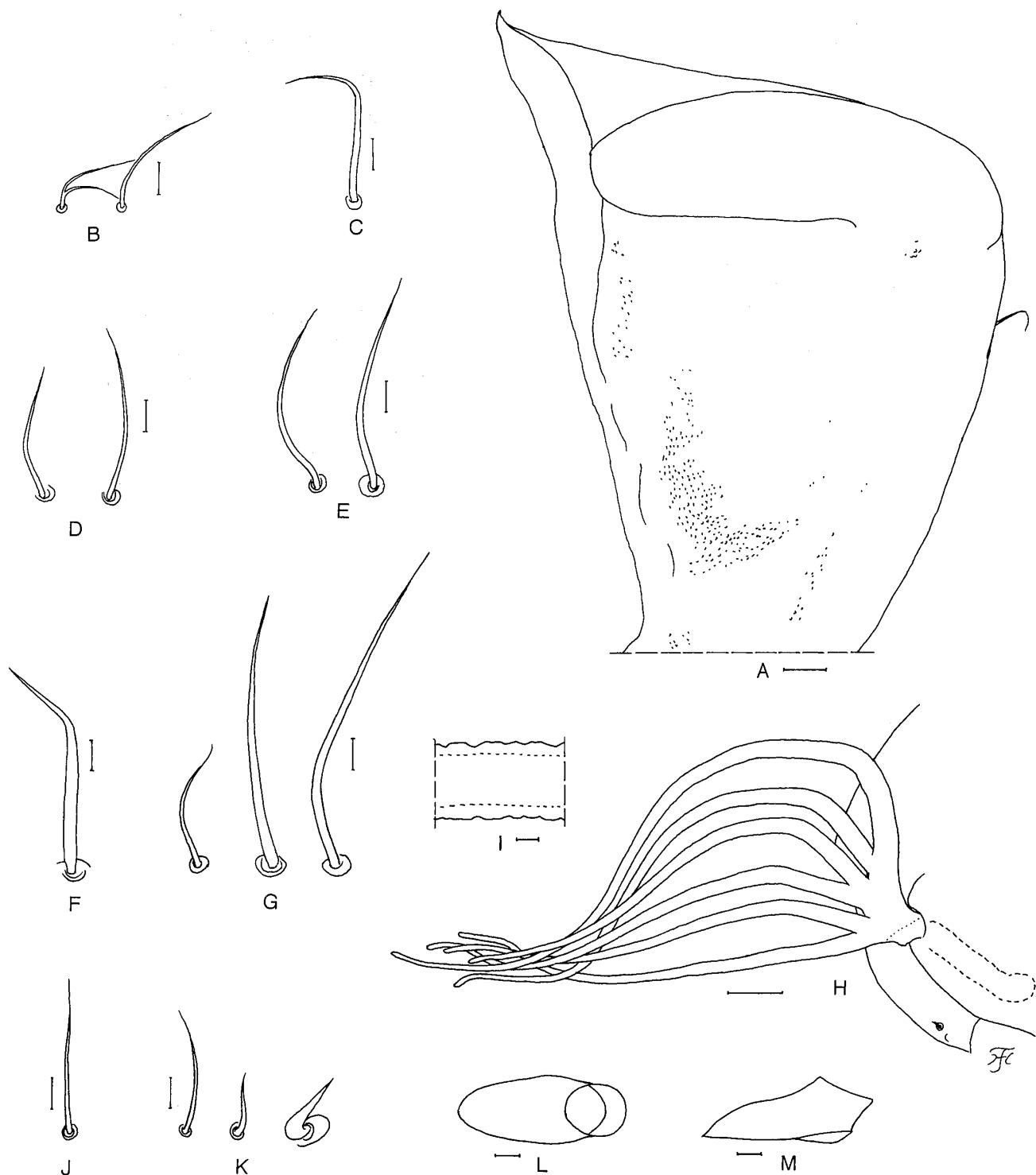


Fig. 2. Pupa of *Simulium (Simulium) maklarini* sp. nov. A, Head (lateral view) showing the limited areas covered with minute tubercles along the posterodorsal margin; B, 2 frontal trichomes *in situ*; C, facial trichome; D-G, trichomes on thorax (D, mediolateral; E, anterolateral; F, posterolateral; G, ventrolateral); H, gill filaments (left side, outer view); I, part of basal 1/3 of dorsalmost filament showing relatively thicker cuticle and annular ridges and furrows; J, hair-like seta on dorsal surface of abdominal segment 1; K, hair-like seta and 2 spinous setae of different stoutness on dorsal surface of abdominal segment 2; L and M, cocoon (L, dorsal view; M, lateral view). Scale bars. 0.5 mm for L and M; 0.1 mm for H; 0.04 mm for A; 0.01 mm for B-G and I-K.

on each side, which is longer than those of frons. **Thorax.** Integument yellowish-brown, bare except dorsal and dorsolateral surfaces of little less than posterior 1/2, and ventrolateral surface of anterior 1/2 moderately covered with cone-shaped tubercles; thorax with 2 simple slender trichomes (1 short, 1 medium-long) (Fig. 2D) mediodorsally, 2 simple medium-long somewhat stout trichomes (Fig. 2E) anterolaterally, 1 simple medium-long stout trichome (Fig. 2F) posterolaterally, and 3 simple trichomes (1 short and slender, 2 long and stout) (Fig. 2G) ventrolaterally on each side. Gill (Fig. 2H) with 6 slender thread-like filaments in pairs; all pairs very short stalked; all filaments nearly lying in vertical plane, light to medium brown, gradually tapered toward apex, slightly increasing in length from ventralmost filament (0.8 mm long) to dorsalmost filament (1.3 mm long) and also in thickness of basal portion from ventral to dorsal (ratio 1.0 : 1.1 : 1.2 : 1.2–1.3 : 1.2 : 1.5); dorsalmost and ventralmost filaments moderately diverged basally at angle of 90 or little more degrees when viewed laterally; cuticle relatively thick, with distinct annular ridges (though not sharply edged when viewed laterally) and furrows throughout length (Fig. 2I), densely covered with minute tubercles of almost similar size. **Abdomen.** Dorsally, segment 1 light yellowish-brown and segments 2–9 almost transparent; segment 1 bare except near each lateral margin moderately covered with minute tubercles, with 1 simple slender short hair-like seta (Fig. 2J) on each side; segment 2 bare, with 1 simple slender short hair-like seta, 2 simple very short spinous setae and 3 simple very stout spinous setae (Fig. 2K) on each side; segments 3 and 4 each with 4 simple hooked spines and 1 simple very short seta on each side; segments 5–7 bare; segment 8 with well developed spine-combs and comb-like groups of minute spines in transverse row on each side; segment 9 bare, without terminal hooks. Ventrally, all segments transparent; segment 4 with 2 simple hooklets and a few simple short setae on each side; segment 5 with pair of bifid hooks submedially and 1 simple very short seta on each side; segments 6 and 7 each with pair of bifid inner and outer hooks widely spaced and 1 simple very short seta on each side. Grapnel-like hooklets absent. **Cocoon** (Fig. 2L, M). Shoe-shaped, moderately and thickly woven, in particular margin of opening

strongly woven, medium brown except limb of opening dark brown, not extending ventrolaterally; individual threads visible; 3.5 mm long by 1.5 mm wide; front collar 0.6 mm high.

**Male and Mature larva.** Unknown.

**TYPE SPECIMEN.** Holotype female (with associated pupal exuviae and cocoon) reared from a pupa collected from a stream in Hot Spring Park, Poring, Sabah, Malaysia, 12. III. 1998 by H. Takaoka and A. Takaoka.

**ECOLOGICAL NOTES.** The pupa of *S. (S.) maklarini* sp. nov. was collected from a fallen tree leaf in the water of a slow-flowing stream (width about 20 cm, water temperature 23.0°C, shaded, altitude about 550 m). Associated species were *Simulium (Gomphostilbia) mindoroense* Takaoka and Tenedero [=formerly reported as *S. (G.) sheilae* Takaoka and Davies by Takaoka (2001)] and *S. (S.) sabahense* Smart and Clifford.

**ETYMOLOGY.** The species name *maklarini* is in honor of Dr. Maklarin Bin Lakim, Research Officer, Research and Education Division, Kinabalu Conservation Center, Kinabalu Park, Sabah, who kindly arranged the field survey in Kinabalu Park in 2007.

**REMARKS.** The female of *S. (S.) maklarini* sp. nov. appears very closely related to *S. (S.) bishopi* Takaoka and Davies from Peninsular Malaysia (Takaoka and Davies, 1995), *S. (S.) crassimanum* Edwards, *S. (S.) laterale* Edwards, and *S. (S.) nigripilosum* Edwards, all described from Sabah (Edwards, 1933; Smart and Clifford, 1969; Takaoka, 1983), and *S. (S.) palawanense* Delfinado from Palawan Island (Delfinado, 1971; Takaoka, 1983) in that the paraproct is markedly produced ventrally, and the eighth sternite is well demarcated from the ovipositor valves. However this new species is distinguished from all these known species by the following characteristics: from *S. (S.) bishopi*

by mid and hind tibiae with a white base (Fig. 1E, F); from *S. (S.) crassimanum* by 1) a whitish-yellow fore coxa, 2) mid and hind tibiae with a white base (Fig. 1E, F), 3) a bare basal section of the radial vein, 4) a silvery iridescence on the tergite 2 (no iridescence on the tergite 2 of *S. (S.) crassimanum* in the key provided by Smart and Clifford, 1969); from *S. (S.) laterale* by 1) mid and hind tibiae with a white base (Fig. 1E, F), 2) a bare basal section of the radial vein, 3) a subbasal tooth on the claw that is longer than its basal width (Fig. 1G) (shorter than its basal width in *S. (S.) laterale* according to figure 17D given by Smart and Clifford, 1969); from *S. (S.) nigripilosum* and *S. (S.) palawanense* by a paraproct that is wider basally than apically in lateral view (Fig. 1J) (narrower basally than apically in *S. (S.) nigripilosum* and *S. (S.) palawanense* according to figures 77b and 75b given by Takaoka, 1983).

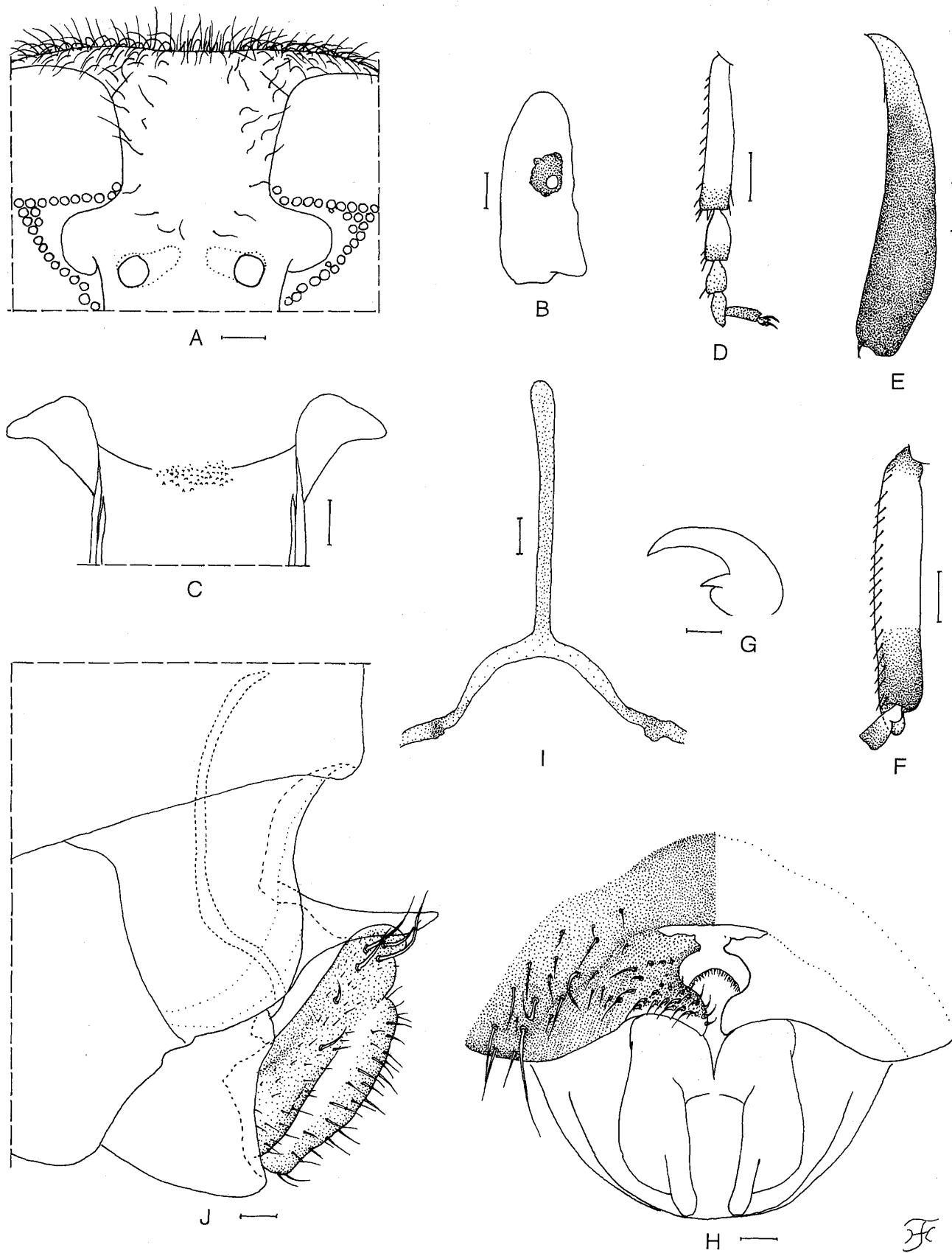
The pupa of this new species is readily distinguished from *S. (S.) kinabaluense* Smart and Clifford described from Sabah (Smart and Clifford, 1969) by head integument that is almost bare in this new species (Fig. 2A) but densely covered with tubercles in *S. (S.) kinabaluense* according to an examination of the type specimen.

### *Simulium (Simulium) liewi* sp. nov.

**DESCRIPTION. Female.** Body length 2.3 mm. **Head.** Narrower than width of thorax. Frons (Fig. 3A) dark brown, shiny, with several dark stout hairs along lateral margins and near lower margin; frontal ratio 1.22 : 1.00 : 0.80; frons-head ratio 1.00 : 3.27. Fronto-ocular area (Fig. 3A) shallow, rounded laterally. Clypeus dark brown, shiny, silvery iridescent when il-

luminated at certain angle of light, moderately covered with dark stout hairs except small area near upper margin and narrow mediolongitudinal area bare. Labrum 0.85 times as long as clypeus. Antenna composed of scape, pedicel, and 9 flagellomeres, dark brown except scape, pedicel and base of 1st flagellomere light to medium brown. Maxillary palp medium brown, composed of 5 segments, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.16 : 1.97; 3rd segment (Fig. 3B) slightly enlarged; sensory vesicle (Fig. 3B) small, ellipsoidal, 0.24 times as long as 3rd segment, with medium-sized round opening near apex. Maxillary lacinia with 9–12 inner and 12 outer teeth. Mandible with 23 inner and 12 outer teeth. Cibarium (Fig. 3C) with 60 minute tubercles. **Thorax.** Scutum brownish-black except pair of triangular submedian spots near anterior margin as well as anterior calli on each side medium brown, markedly shiny, silvery iridescent when illuminated at certain angle of light, moderately covered with light to medium brown recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Other characters similar to those of *S. (S.) maklarini* sp. nov. **Legs.** Foreleg: coxa and trochanter light to medium brown; femur medium brown except apical cap dark brown; tibia medium brown except outer surface whitish, and with silvery iridescence when illuminated at certain angle of light; tarsus dark brown, with thick dorsal crest of short hairs; basitarsus greatly dilated, 3.61 times as long as its greatest width. Midleg: coxa, trochanter and femur dark brown; tibia dark brown except base narrowly light brown, with silvery iridescence on posterior surface when illuminated at certain angle of light; basitarsus and 2nd tarsal segment (Fig. 3D) mostly whitish-yellow except apical tip light to medium brown; rest of tarsus (Fig. 3D) light to medium brown except base of 3rd segment whitish-yellow. Hind leg: coxa and trochanter medium brown; femur medium brown except

Fig. 3. Female of *Simulium (Simulium) liewi* sp. nov. A, middle part of head showing wide frons and shallow fronto-ocular areas (front view); B, 3rd segment of maxillary palp with sensory vesicle (right side; front view); C, cibarium; D, tarsus of midleg (left side, outer view); E, tibia of hind leg (left side, outer view); F, basitarsus and 2nd tarsal segment of hind leg showing calcipala and pedisulcus (left side, outer view); G, claw; H, 8th sternite and ovipositor valves *in situ* (ventral view); I, genital fork (ventral view); J, posterior tip of abdomen showing 8th sternite, ovipositor valve, genital fork, paraproct and cercus *in situ* (lateral view). Scale bars. 0.1 mm for D–F; 0.05 mm for A; 0.02 mm for B, C and H–J; 0.01 mm for G.

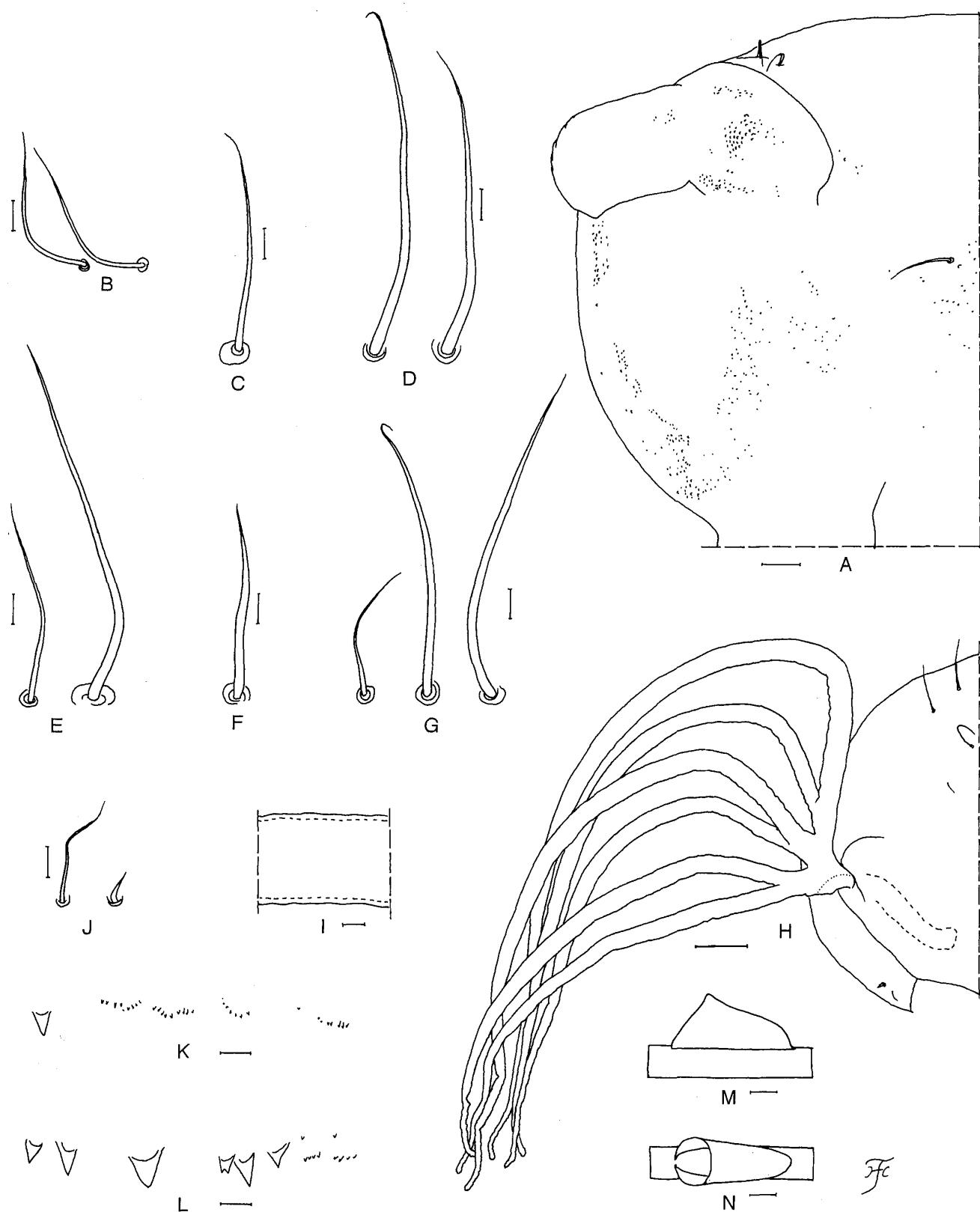


apical cap dark brown; tibia (Fig. 3E) dark brown except base light yellowish-brown, with silvery iridescence on posterior surface when illuminated at certain angle of light; tarsus (Fig. 3F) medium brown except little more than basal 2/3 of basitarsus (though base light brown) and little less than basal 1/2 of 2nd segment yellowish-white; basitarsus nearly parallel-sided, 5.73 times as long as its greatest width, 0.71 and 0.65 times as wide as greatest width of hind tibia and femur, respectively; calcipala nearly as long as width at base; pedisulcus distinct. All claws (Fig. 3G) with small subbasal tooth longer than its basal width. **Wing.** Length 2.1 mm. Costa with spinules and hairs. Subcosta haired except apical 1/2 bare. Basal section of vein R bare;  $R_1$  with spinules and hairs;  $R_2$  with hairs only. Hairs at base of stem vein dark brown. Basal cell absent. **Halter.** White with base light brown. **Abdomen.** Basal scale medium brown, with fringe of long hairs. Dorsal surface of abdominal segments medium brown except tergites of segments 3 and 4 somewhat darker, with dark hairs; tergite of 2nd segment with pair of large silvery iridescent dorsolateral spots broadly connected to each other medially; tergites 6–8 shiny. Ventral surface of abdominal segment 7 with large sternal plate medially. **Genitalia.** Sternite 8 (Fig. 3H) well sclerotized, moderately depressed medially, covered with 16–20 short to long hairs on each side, with posterior margin well demarcated from ovipositor valves; ovipositor valve (Fig. 3H) membranous, tapered posteriorly with transparent bare pointed apex, acutely bent ventrally, and covered with about 36 short to long hairs on outer surface; inner margins well sclerotized, widely concave medially, moderately separated apically from each other. Genital fork (Fig. 3I) of inverted-Y form; stem slender and moderately sclerotized, with apex not dilated; arms slender, each with moderately-

sclerotized lateral ridge. Paraproct in lateral view (Fig. 3J) much produced ventroposteriorly, about 3.3 times as wide as its basal length, covered with several medium-long stout hairs and numerous short fine hairs on lateral surface; paraproct anteroventrally with thin elongate slightly-sclerotized plate having round apical tip and about 10 short setae scattered on its surface. Cercus in lateral view (Fig. 3J) very short, with posterior margin somewhat convex, about 4.3 times as wide as its greatest length, and covered with numerous hairs. Spermatheca depressed, then its shape and size not determined, well sclerotized except duct and wide area of juncture to duct unsclerotized, without reticulate surface patterns; minute internal setae present; both accessory ducts subequal in diameter to each other, and also to that of main duct.

**Pupa.** Body length (excluding gill filaments) about 2.5 mm. **Head.** Integument dark brown except anteroventral and lateral surfaces light yellowish-brown, bare except some areas including base of facial trichome, base of antennal sheath, and narrow area along posterolateral margin on each side, sparsely or moderately covered with minute tubercles (Fig. 4A); frons with 2 simple medium-long trichomes moderately separated from each other (Fig. 4B) on each side; face with 1 simple medium-long trichome (Fig. 4C) on each side, which is longer than those of frons. **Thorax.** Integument dark brown except posterior 1/2 light to medium brown, bare except dorsal and dorsolateral surfaces of little less than posterior 1/2, and ventrolateral surface of anterior 1/2 moderately covered with cone-shaped tubercles; thorax with 2 simple long stout trichomes (Fig. 4D) mediodorsally, 2 simple trichomes (1 medium-long and slender, 1 long and stout) (Fig. 4E) anterolaterally, 1 simple stout medium-long trichome (Fig. 4F) posterolaterally, and 3 simple trichomes (1 short and slender, 2 long

Fig. 4. Pupa of *Simulium (Simulium) liewi* sp. nov. A, head (right half, anteroventral view) showing the limited areas covered with minute tubercles on face, on antennal sheath, and along the posterodorsal margin; B, 2 frontal trichomes *in situ*; C, facial trichome; D–G, trichomes on thorax (D, mediodorsal; E, anterolateral; F, posterolateral; G, ventrolateral); H, gill filaments (left side, outer view); I, part of basal 1/3 of dorsalmost filament showing relatively thinner cuticle and lack of annular ridges; J, hair-like seta and slender spinous seta on dorsal surface of abdominal segment 2; K, distinct spine and comb-like groups of minute spines on dorsal surface of abdominal segment 7 (right side, dorsal view); L, distinct spines (spine-combs) and comb-like groups of minute spines on dorsal surface of abdominal segment 8 (right side, dorsal view); M and N, cocoon on slender plant root (M, lateral view; N dorsal view). Scale bars. 0.5 mm for M and N; 0.1 mm for H; 0.04 mm for A; 0.01 mm for B–G and I–L.



and stout) (Fig. 4G) ventrolaterally on each side. Gill (Fig. 4H) with 6 slender thread-like filaments in pairs; all pairs short stalked; all filaments nearly lying in vertical plane, light brown, nearly parallel-sided or slightly widened from base through basal 2/3, then gradually tapered toward apex, slightly increasing in length from ventralmost filament (about 1.0 mm long) to dorsalmost filament (1.7 mm long) but different in thickness of basal portion from ventral to dorsal (ratio 1.15 : 1.15 : 1.00 : 1.2 : 1.00 : 1.40); dorsalmost and ventralmost filaments widely diverged basally at angle of about 120 degrees when viewed laterally; cuticle relatively thin, with annular furrows subbasally at irregular intervals but no distinct annular ridges (Fig. 4I), and densely covered with minute tubercles of almost similar size. **Abdomen.** Nearly as in *S. (S.) maklarini* sp. nov. except following characteristics: dorsally, segment 1 bare except small area near each lateral margin very sparsely covered with minute tubercles; segment 2 with 1 simple slender short hair-like seta and 5 simple very short spinous setae (Fig. 4J) on each side; segment 7 with 1 distinct spine and comb-like groups of minute spines in transverse row (Fig. 4K) on each side [1 distinct spine similar in size to those of spine-combs on segment 8 (Fig. 4L)]; ventrally, segment 4 with a few simple short setae only on each side. **Cocoon** (Fig. 4M, N). Wall-pocket-shaped, thickly woven (in particular, limb of opening), light yellowish-brown, not extending ventrolaterally; individual threads invisible; 2.6 mm long by 1.0 mm wide.

**Male and mature larva.** Unknown.

**TYPE SPECIMEN.** Holotype female (with associated pupal exuviae and cocoon) reared from a pupa collected from a stream at Timpohon, upstream of the water reserve just above the Carson Fall, near the gate for the trail to Mt. Kinabalu, Sabah Parks, Sabah, Malaysia, 3. III. 1998 by H. Takaoka.

**ECOLOGICAL NOTES.** The pupa of *S. (S.) liewi* sp. nov. was collected from a slender plant root trailing in the water of a small clean stream (width 10–40 cm, streambed rocky, water temperature 13°C, shaded, altitude 1,970 m) moderately or

rapidly flowing in a natural forest. Associated species were *Simulium (Gomphostilbia) guniki* Takaoka, S. (*Nevermannia*) *borneoense* Takaoka and *S. (S.) aeneifacies* Edwards.

**ETYMOLOGY.** The species name *liewi* is in honor of Dr. F. S. P. Liew, Sabah Parks, who kindly arranged the field survey in 1998.

**REMARKS.** *Simulium (S.) liewi* sp. nov. is similar to *S. (S.) crassimanum* Edwards described from Sabah (Edwards, 1933; Smart and Clifford, 1969; Takaoka, 1983) in having a similar leg color including a dark fore coxa and mostly yellowish first and second mid tarsal segments (Fig. 3D). However, this new species is distinguished by the following characteristics (those of *S. (S.) crassimanum* in parentheses): basal section of the radial vein bare (haired according to the redescription by Smart and Clifford, 1969), halter white (orange according to the key by Smart and Clifford, 1969), tergite 2 iridescent (not iridescent according to the key by Smart and Clifford, 1969), and stem of the genital fork without an apical dilatation (Fig. 3I) (with a large dilatation according to figure 76a illustrated by Takaoka, 1983).

The pupa of *S. (S.) liewi* sp. nov. is distinctive among the *melanopus* species-group in that the cocoon is wall-pocket-shaped (Fig. 4M, N), and the gill filaments lack annular ridges on the cuticular surface (Fig. 4I).

#### ACKNOWLEDGEMENTS

I am grateful to Prof. Yon Hoi Sen, Malay University, Dr. F. S. P. Liew and Dr. Gunik Gunsalam, Sabah Parks, for their kind help and arrangements for collections of black flies from the field in 1998. Thanks are due to Ms. T. Howard, the Natural History Museum, London, U. K., for her kind loan of the type specimens needed for this study.

This study was financially supported by

a Grant-in-Aid for Oversea Research from the Japan Society for the Promotion of Science (No. 18406011).

#### REFERENCES

Delfinado, M. 1971. Some Simuliidae and Curtonotidae from the Philippines and the Bismarck Islands (Insecta, Diptera). *Steenstrupia*, 1: 131–139.

Edwards, F. W. 1933. Diptera Nematocera from Mount Kinabalu. *J. fed. Malay St. Mus.*, 17: 223–296.

Smart, J. and Clifford, E. A. 1969. Simuliidae (Diptera) of Sabah (British North Borneo). *Zool. J. Linn. Soc.*, 48: 9–47.

Takaoka, H. 1983. The Blackflies (Diptera: Simuliidae) of the Philippines. xii+199 pp., The Japan Society for the Promotion of Science, Tokyo.

Takaoka, H. 1996. Description of a new species of *Simulium* (*Simulium*) from Sabah, Malaysia (Diptera: Simuliidae). *Jpn. J. Trop. Med. Hyg.*, 24: 157–161.

Takaoka, H. 2001. Two new and three newly recorded species of black flies (Diptera: Simuliidae) from Sabah, Malaysia. *Jpn. J. Trop. Med. Hyg.*, 29: 221–230.

Takaoka, H. 2003. The Black Flies (Diptera: Simuliidae) of Sulawesi, Maluku and Irian Jaya. xxii+581 pp., Kyushu University Press, Fukuoka.

Takaoka, H. and Davies, D. M. 1995. The Black Flies (Diptera: Simuliidae) of West Malaysia. viii+175 pp., Kyushu University Press, Fukuoka.